5.2 RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE

Onsite surveillance of airborne particulates, noble gases, and HTO vapor indicated concentrations that, with a few exceptions, were generally not statistically different from background concentrations. Tritium effluent was detectable from the low-level radioactive waste (LLW) site in Area 5 and plutonium was detectable on air samples at several locations on and off the NTS. Surface water samples collected from open reservoirs or natural springs and industrial-purpose water, exclusive of tunnel ponds, gave no indication of statistically significant contamination levels. External gamma exposure monitoring results indicated little change from 1995. A special environmental study measured tritium in water of plants collected NTS-wide. Results of offsite environmental surveillance by the EPA R&IE-LV showed that no NTS-related radioactivity was detected by the offsite monitoring networks and that there were no apparent net exposures detectable by the offsite dosimetry network.

ONSITE ENVIRONMENTAL SURVEILLANCE

At the end of 1996, the onsite radiological surveillance networks consisted of 45 air sampling stations; 3 radioactive noble gas sampling stations; 12 HTO vapor sampling stations; surface water samples from 8 open water supply reservoirs, 7 springs, 8 containment ponds plus an effluent, and 8 sewage lagoons; groundwater samples from 10 potable and 2 non-potable supply wells and 7 tap water locations; and 160 locations where TLDs measure gamma exposures. Summary tables for each of the analytes for this program are placed at the end of this chapter. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

RADIOACTIVITY IN AIR

A total of 49 air sampling stations were operated at various times during the year. Four stations were deleted and four new ones added, so the network ended the year with 45 stations. Solar-photovoltaic, battery-powered samplers were placed at ten locations in or near contaminated areas where commercial power was unavailable. At each of the stations, particulate samples were collected weekly on glass-fiber filters. The filters were counted for gamma and gross alpha/beta activity, composited monthly for RWMS samplers, or quarterly for the remainder of the sampling locations, and then analyzed for ^{238}Pu and $^{239+240}Pu$. Due to the lack of any sources for airborne halogens, charcoal filters were not used in the air samplers this year.

In an effort to reduce analytical costs, gross alpha analyses of collected particulate filters was begun about midyear and compared to the later plutonium analyses. In general, there was no relation between gross alpha analyses (units of 10^{-15} µCi/mL) and $^{239+240}Pu$ analyses (units of 10^{-18} µCi/mL). However, all gross alpha analyses were above the mean minimum detectable concentration (MDC), so this monitoring will continue until the source of the alpha activity is identified. Air monitoring for the noble gases began at

six fixed locations that were reduced to three by year's end. These air samples were collected weekly. A distillation process separated the radioactive noble gases from the sample for measurement.

HTO vapor was monitored at 16 locations on the NTS, but for only a portion of the year at five locations which were either terminated or added during the year. There were 12 sampling locations by the end of the year. Samples were collected every two weeks and analyzed for ^{3}H. Liquid scintillation counting was used for these measurements.

For the purpose of comparing measured quantities of airborne radioactivity to the Derived Air Concentrations (DAC), the guides for occupational exposures found in DOE Order 5480.11, and to the DCG, the guides for exposures to members of the general public found in DOE Order 5400.5, the following assumptions were made:

- The chemical species of the radionuclides detected was unknown so the most restrictive DAC or DCG was used (almost always Class Y compounds which take on the order of years to clear from the respiratory system). The DCG and DAC values used are listed in Table 5.6.

- For air sampling results, all of the gross beta activity detected was assumed to be ^{90}Sr, and the gross alpha activity was assumed to be naturally occurring uranium, thorium, and progeny.

AIR SAMPLING RESULTS

GROSS ALPHA

Figure 5.3 displays the average NTS gross alpha results for 1996. Air particulate samples were held for five to seven days prior to gross alpha/beta counting and gamma spectrum analysis, to allow for the decay of radon and radon progeny. Table 5.2 presents the network arithmetic averages, minimums, and maximums for gross alpha in air during 1996. All results exceeded the MDC. The network 1996 annual average gross alpha concentration was 2.1×10^{-15} µCi/mL (0.08 mBq/m^3). This concentration is about 0.03 percent of the $^{239+240}Pu$ DAC listed in DOE Order 5480.11 and about 100 percent of the 10 mrem DCG in DOE Order 5400.5. A statistical evaluation of the gross alpha concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution.

GROSS BETA

Figure 5.4 displays the average NTS gross beta results for 1996, and Table 5.3 presents the network arithmetic averages, minimums, and maximums for gross beta in air. All results exceeded the MDC, except for instances where the sample volume was unusually low. The network 1996 annual average gross beta concentration was 1.8×10^{-14} µCi/mL (0.67 mBq/m^3), slightly less than in 1995. This concentration is about 0.001 percent of the ^{90}Sr DAC listed in DOE Order 5480.11 and less than 3 percent of the 10 mrem DCG in DOE Order 5400.5. A statistical evaluation of the gross beta concentrations indicated that a lognormal distribution provides an adequate approximation to the true distribution. Although the average gross beta concentration for all stations was similar to last year's, the trend of weekly averages was different, being almost sinusoidal rather than increasing gradually throughout the year.

PLUTONIUM

The composite filter samples from each particulate sampling location were analyzed for ^{238}Pu and $^{239+240}Pu$. Figure 5.5 shows the airborne $^{239+240}Pu$ annual average results for each of the sampling locations. Tables 5.4 and 5.5 list the maximum, minimum, annual arithmetic mean, standard deviation, and the mean expressed as a percentage of the DCG for each sampling location, for $^{239+240}Pu$ and ^{238}Pu, respectively. The ranges in the annual mean concentrations for ^{238}Pu and

Click to view Figure 5.3

Figure 5.3 NTS Airborne Gross Alpha Annual Average Concentrations - 1996

Click to view Figure 5.4

Figure 5.4 NTS Airborne Gross Beta Annual Average Concentrations - 1996

Click to view Figure 5.5

Figure 5.5 NTS Airborne $^{239+240}$Pu Annual Average Results - 1996

$^{239+240}$Pu for all stations were -0.018 to 1.1 x 10^{-17} µCi/mL and 0.054 to 45 x 10^{-17} µCi/mL (-0.007 to 0.41 and 0.02 to 17 µBq/m^3), respectively. The arithmetic mean and standard deviation of ^{238}Pu in air for all stations were (1.0 ± 2.5) x 10^{-18} µCi/mL (0.037 ± 0.093 µBq/m^3). Most observed values of ^{238}Pu were well below the limit of detection. The arithmetic mean and standard deviation of $^{239+240}$Pu in air for all stations were (5.2 ± 14) x 10^{-17} µCi/mL (1.9 ± 5.2 µBq/m^3). The network arithmetic mean for $^{239+240}$Pu was 62 percent higher than the 1995 mean concentration, an increase that is within the statistical variation of all results.

During 1996, the maximum annual average $^{239+240}$Pu concentration was found at the Area 52 DOUBLE TRACKS (probably due to cleanup activities) and the next highest at the Area 9 9-300 Bunker sampling locations. Results from samples taken at the DOUBLE TRACKS site averaged 45 x 10^{-17} µCi/mL (17 µBq/m^3) during 1996. This quantity was less than 1 percent of the DAC and 23 percent of the 10 mrem DCG. Historically, the highest concentrations of $^{239+240}$Pu have occurred in Areas 3 and 9. A statistical analysis of the $^{239+240}$Pu results suggests that, due to the heterogeneity of the variances, the differences among the areas are not statistically significant.

The presence of plutonium on the NTS is primarily due to atmospheric tests and tests in which nuclear devices were detonated with high explosives ("safety shots"). These latter tests spread low-fired plutonium in the eastern and northeastern areas of the NTS and in several areas in near offsite locations (see Chapter 2, Figure 2.3 for these locations). Two decades later, measurable levels of plutonium in air are still present, because meteorological and operational activities and vehicular traffic in these areas resuspend some of the ^{238}Pu and $^{239+240}$Pu in the soil.

GAMMA

The glass-fiber filters used to collect particulates were analyzed by gamma spectroscopy. The only radionuclides detected by gamma spectroscopy were naturally occurring in the environment (^{40}K, ^{7}Be, and members of the uranium and thorium series), except for traces of an event-related radionuclide ,^{137}Cs, which was detected in nine samples. The concentration of ^{137}Cs in these samples was <0.1 percent of the 10 mrem DCG.

NOBLE GAS SAMPLING RESULTS

The three locations at which compressed air samples were routinely collected throughout the year are shown in Figure 5.6 with the annual averages of the ^{85}Kr analyses. All average concentrations were well below the DCG values of 3 x 10^{-7} µCi/mL (1.1 x 10^{4} Bq/m^3) for ^{85}Kr. Summaries of the results are listed in Table 5.7. Individual results for each collected sample are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11717-138, in prep.).

As in the past, the levels of ^{85}Kr (half-life of 10.76 years) observed in the samples were from worldwide nuclear power and fuel processing operations, with possibly a small contribution of ^{85}Kr from underground nuclear tests conducted at the NTS. Xenon-133 analyses were not done this year, because its short half-life of 5.27 days and the moratorium on tests makes it unlikely that any would be detected on the NTS.

Again this year, the highest annual average concentration occurred in Area 20, at the Area 20 Camp, 26 x 10^{-12} µCi/mL (0.96 Bq/m^3), which is <0.01 percent of the 10 mrem DCG. The higher average for the samples collected in Area 20 was expected as it has been consistently higher in the past. However, statistical evaluation of these data showed that the average concentration for Area 20 was not significantly higher than the other averages at the 5 percent significance level. Each location had environmental levels of ^{85}Kr with occasional spikes attributed to

Click to view Figure 5.6

Figure 5.6 NTS ^{85}Kr Annual Average Concentrations - 1996

analytical problems and/or seepage of noble gases from the Pahute Mesa area. All data since 1982 were evaluated for any trend in concentrations. The network average ^{85}Kr concentrations were found to have remained relatively constant over this period.

TRITIATED WATER VAPOR SAMPLING RESULTS

The concentrations of HTO vapor determined from sampling conducted at the 16 NTS sampling stations are summarized in Table 5.8. Individual results for each collected sample and a statistical evaluation of the data are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996," (DOE/NV/11718-138, in prep.).

As shown in Table 5.8, the location having the highest annual average tritium concentration was the Area 12 E Tunnel Pond station with an average of 12×10^{-6} pCi/mL (0.44 Bq/m^3). This average was only 0.12 percent of the 10 mrem DCG for tritium. The annual average concentration at each station is shown in Figure 5.7 with the data for RWMS-5 in Figure 5.2.

The data were found to be lognormally distributed, therefore the natural logarithms of the individual concentrations were used in a one-way analysis of variance to test for differences between station means. This statistical testing also identified two separate groups of stations; the higher group includes stations known to be near sources of tritium, such as RWMS-5, the SEDAN crater, and the E Tunnel pond.

A review of the historical trend in concentrations at the NTS over the years 1982 through 1996 was made. The review found that the average tritium concentration for all environmental stations showed an exponential decrease from about 1.4×10^{-4} pCi/mL in 1982 to about 4.0×10^{-5} pCi/mL in 1987, followed by a decrease to the current value, 3.5×10^{-6} pCi/mL. The same trend was observed at all environmental stations, including the RWMS stations, which implies that the RWMS, although emitting measurable tritium, may not be the only source of tritium at the NTS.

RADIOACTIVITY IN SURFACE WATER

Surface water sampling at the NTS was conducted at eight open reservoirs, seven natural springs, eight containment ponds and an effluent, and eight sewage lagoons. The locations of these sources are shown in Figure 4.4. When water was available and the weather permitted, a grab sample was taken quarterly. The sample was analyzed for ^{3}H, gross beta, gamma activity, ^{238}Pu, $^{239+240}Pu$, and ^{90}Sr according to the schedule shown in Table 4.1. Sources of surface water were, for the most part, man-made; i.e., created for or by NTS operations. There is no known human consumption of any surface water on the NTS.

The annual average for each radionuclide analyzed in surface waters is presented in Table 5.9, along with the results from analysis of tunnel effluents. The annual averages for open reservoirs and natural springs (see Figure 5.8) are compared to the DCGs for ingested water. Gamma results for all sample locations indicated that radionuclide levels were consistently below the detection limit, except for samples from the E Tunnel effluent and ponds which had concentrations ranging up to 1.5×10^{-6} µCi/mL.

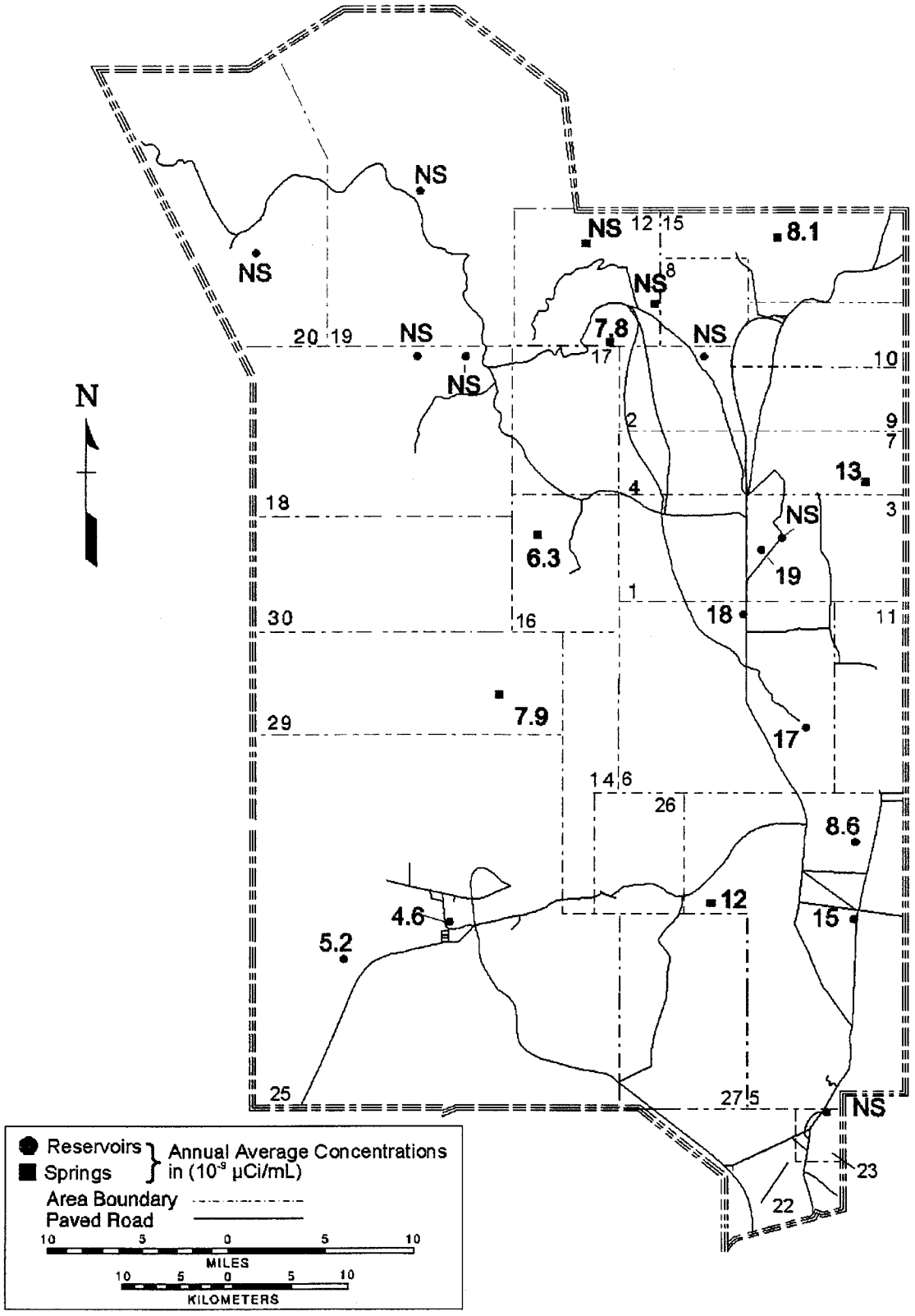
With the exception of containment ponds, no annual average concentration in surface waters was found to be statistically different from any other at the 5 percent significance level. The analytical results from the Area 12 containment ponds showed measurable quantities of radioactivity and displayed identifiable trends.

OPEN RESERVOIRS

Open reservoirs have been established at various locations on the NTS for industrial uses. The annual average concentrations of

Click to view Figure 5.7

Figure 5.7 NTS HTO Vapor Annual Average Concentrations - 1996



Note: NS - No Sample, Reservoir Dry

Figure 5.8 Annual Average Gross Beta in Surface Water - 1996

gross beta were compared to the DCGs for ingested water listed in DOE Order 5400.5, even though there was no known consumption of these waters. The appropriate data are shown in Table 5.10.

NATURAL SPRINGS

Of the nine natural springs found onsite, (i.e., spring-supplied pools located within the NTS), only seven had enough water to be sampled. These springs were a source of drinking water for wild animals on the NTS. The annual average gross beta results for each spring are shown in Table 5.11 and compared to the ^{90}Sr DCG for drinking water, although the water is not used for drinking. The highest result was for Area 7, Reitman Seep, but it was still below the DCG.

CONTAINMENT PONDS

Due to the sealing of the tunnels by the end of the year 1993, liquid effluents ceased at all except E Tunnel. The E Tunnel containment pond was fenced and posted with radiological warning signs. During each sampling, a grab sample was taken from the E Tunnel containment pond and at the effluent discharge point. The samples were analyzed for ^{3}H, ^{90}Sr, ^{238}Pu, $^{239+240}$Pu, gross beta, and gamma activity in accordance with the schedule in Table 4.1. The annual average of gross beta analyses from each sampling location is listed in Table 5.12 and compared to the DCG for ingested water. This water is not used for drinking.

The effluent from characterization wells drilled in Area 20 was discharged into containment ponds. The total liquid discharged was calculated from the measured area and water depth of the pond. By multiplying that volume by the averaged ^{3}H concentration of collected samples, shown in Table 5.9, the total amount of tritium discharged (130 Ci or 4.8 Tbq) was calculated.

SEWAGE LAGOONS

Samples were collected quarterly during this year from eight sewage lagoons on the network at the end of 1996. Each of the lagoons is part of a closed system used for evaporative treatment of sanitary waste. The lagoons are located in Areas 5, 6, 12, 22, 23, and 25. There was no known contact by the working population during the year. The annual gross beta concentration averages for all lagoons ranged between 7.7 and 33 x 10^{-9} µCi/mL (0.28 to 1.2 Bq/L). No radioactivity was detected above the MDCs for ^{3}H or ^{90}Sr. No event-related radioactivity was detected by gamma spectrometric analyses.

Concentrations of ^{238}Pu and $^{239+240}$Pu above the MDC were found in the February 13 sample from the Area 23 Sewage Lagoon. The respective concentrations were 6.3 x 10^{-11} and 3.3 x 10^{-9} µCi/mL (0.0023 and 0.12 Bq/L). This was attributed to accumulation of old fallout (from tests in the atmosphere in the 1950s and 1960s) in the sewer-line sediments, which became loosened when the lines were flushed with water. Sediment samples collected from the sewage lagoon, after this finding was noted, also had detectable levels of plutonium. The radiochemistry laboratory that uses the same sewer system was eliminated as a source since the ratio of $^{239+240}$Pu to ^{238}Pu in the sediment was 50, (the range of that ratio in air and soil samples is 50 to 100) while that ratio in the laboratory standard was 3,000.

RADIOACTIVITY IN SUPPLY WELL WATER

The principal water distribution system on the NTS is potentially the critical pathway for ingestion of waterborne radionuclides. Consequently, the water distribution system is sampled and evaluated frequently. At the start of 1996, the NTS water system consisted of 12 supply wells, 10 of which supplied potable water to onsite distribution systems. The drinking water is pumped from the wells to the points of consumption. The supply wells were sampled on a quarterly basis. Drinking water is sampled at end-points to provide a constant check of

the radioactivity and to allow end-use activity comparisons to the radioactivity of the water in the supply wells. In this section, analytical results are presented from samples taken at the 12 supply wells. Each well was sampled and analyzed as noted in the schedule in Table 4.1.

The locations of the supply wells are shown in Figure 5.9. Water from these wells (ten potable and two nonpotable) was used for a variety of purposes during 1996. Samples were collected from those wells which could potentially provide water for human consumption. These data were used to help document the radiological characteristics of the NTS groundwater system. The sample results are maintained in a database so that long-term trends and changes can be studied. Table 5.13 lists the drinking water sources, and Table 5.14 lists the potable and nonpotable supply wells and their respective radioactivity averages. No event-related radionuclides were detected by gamma spectrometry. Included in the table are the median MDCs for each of the measurements for comparison to the concentration averages for each location. For various operational reasons, samples could not be collected from all locations every sampling period.

GROSS BETA

As shown in Table 5.14, the gross beta concentration averages for all the supply wells were above the median MDC of the measurement. The highest average gross beta activity occurred at Well C1 and was 1.4×10^{-8} µCi/mL (0.52 Bq/L), which was 4.7 percent of the DCG for ^{40}K and 35 percent of the DCG for ^{90}Sr based upon 4 mrem effective dose equivalent (EDE) per year. In earlier reports (Scoggins 1983 and Scoggins 1984), it was noted that the majority of gross beta activity was attributable to naturally occurring ^{40}K. The gross beta annual averages are shown at their supply well sampling locations in Figure 5.9. All concentration averages were comparable to those reported last year.

TRITIUM

As shown in Table 5.14 the average tritium concentrations at all locations were below the average MDC of the measurement (note that the MDC was 14×10^{-9} µCi/mL, based on tritium enrichment analysis).

PLUTONIUM

All supply water samples analyzed for ^{238}Pu and $^{239+240}$Pu had concentrations below their MDC's of about 2.0×10^{-11} µCi/mL, which are 1.9 and 2.0 percent of their respective DCGs adjusted to a 4 mrem EDE per year. Table 5.14 lists the concentration averages for these nuclides for each location.

GROSS ALPHA

As shown in Table 5.14, the average gross alpha concentration for all of the supply wells, except for Well 8, were above the median MDC of 1.4×10^{-9} µCi/mL. The highest concentration from the potable wells occurred in samples from the Area 5, Well 5C, and was 12×10^{-9} µCi/mL (0.44 Bq/L). This is acceptable according to the EPA drinking water standard (Title 40 Code of Federal Regulations [C.F.R.] 141) as long as the combined concentration of ^{226}Ra and ^{228}Ra is less than 5×10^{-9} µCi/mL (0.18 Bq/L). The combined Ra concentration for this well was less than the combined MDC of 3.2×10^{-9} µCi/mL (0.12 Bq/L).

STRONTIUM

Beginning in 1994, ^{90}Sr analyses were changed from annually to quarterly on samples collected from the potable supply wells, but analyses on non-potable supply wells remained on an annual basis. The concentration averages of ^{90}Sr for each location, as shown in Table 5.14, were below the median MDC.

RADIOACTIVITY IN DRINKING WATER

As a check on any effect the water distribution system might have on water

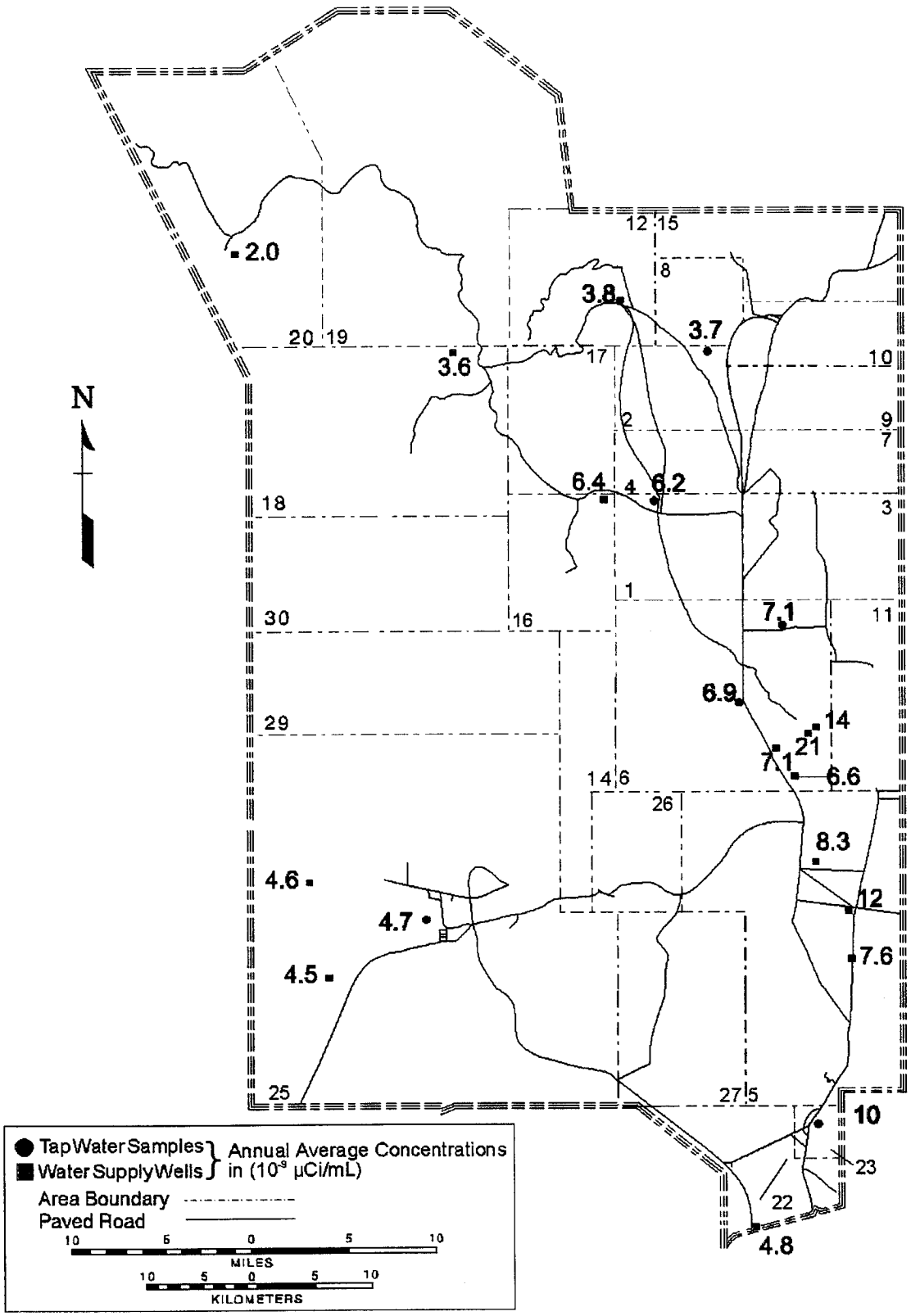


Figure 5.9 Annual Average Gross Beta in Supply Wells and Tap Water - 1996

quality, seven water system end-points (labeled tap water in Figure 5.9) were sampled. In order to ensure that all of the water available for consumption was being considered, each drinking water system was identified. The drinking water network at the NTS was found to consist of five drinking water systems. The components of the five are shown in Table 5.13. These systems, fed by ten potable supply wells, are the source of the water for seven end-points. Table 5.15 lists the annual concentration averages for all the analyses performed on the end-point samples. No event-related radionuclides were detected by gamma spectrometry.

GROSS BETA

As in previous years, the gross beta concentration averages for all end-points were above the median MDC of the measurements. The highest annual average occurred in the Area 23 Cafeteria, 10×10^{-9} µCi/mL (0.37 Bq/L). This annual average was 3.3 and 25 percent of the DCG for ^{40}K and ^{90}Sr, respectively, adjusted to an annual 4 mrem EDE.

TRITIUM

The annual average tritium concentrations, as shown in Table 5.15, were all less than the median MDC of 7.2×10^{-7} µCi/mL. The tritium concentrations for all end-point water samples, which were determined by a conventional liquid scintillation counting method, are expected to be lower than the MDC, because the levels of tritium in the potable supply wells were near the median tritium enrichment MDC of 1.4×10^{-8} µCi/mL (0.52 Bq/L). These MDC values are 0.9 percent and 0.018 percent, respectively, of the drinking water DCG adjusted to a 4 mrem (0.04 mSv) EDE.

PLUTONIUM

The annual averages of $^{239+240}Pu$ and ^{238}Pu for each end-point were below the median MDC of the measurements, which were both less than 2 percent of the 4 mrem DCG. These isotopes are not normally detected in drinking water.

GROSS ALPHA

In accordance with the National Primary Drinking Water Regulations (Title 40 C.F.R. 141), gross alpha measurements were made on quarterly samples from the drinking water systems, namely the potable supply wells reported in the previous section of this report. As added assurance that no radioactivity gets into the systems between the supply wells and end-point users, measurements of gross alpha are also made on quarterly samples from the end-points. As shown in Table 5.15, the annual concentration averages for gross alpha radioactivity in tap water samples collected at five locations, exceeded the screening level at which ^{226}Ra analysis is required, 5 pCi/L (0.19 Bq/L). Samples from the supply wells were collected and analyzed for both ^{226}Ra and ^{228}Ra. As shown by the radium results in Table 5.16, the sum of the average concentrations for ^{226}Ra and ^{228}Ra were all less than 5 pCi/L so the onsite systems were in compliance with drinking water regulations.

STRONTIUM

As indicated by Table 5.15, the ^{90}Sr results for samples collected from all the selected end-points had concentrations that were less than the median MDC of the measurements.

TRITIUM CONCENTRATIONS IN NTS VEGETATION

Previous studies of radioactivity in vegetation collected on the NTS have reported tritium in the water from plants collected in areas assumed to be non-contaminated. To explore this finding, a project was initiated to collect water from plants from known contaminated areas as well as from plants from control areas.

Samples were collected around known sources at two random points per square minute (approximately one square nautical mile) and at one random point per five square minutes elsewhere. The deepest rooted trees or shrubs in the area were sampled preferentially, usually two plants

per location. Water was distilled at low temperatures from the samples and analyzed by the standard tritium-in-air procedures (2.5 mL counted for 70 minutes). Summary results are shown in Table 5.17.

Six of the samples with higher concentration (10^{-4} µCi/mL range) came from *Tamarix* sp. trees growing in the CAMBRIC ditch, used to determine if there were diurnal fluctuations in plant tritium content. No diurnal variation was seen, so sampling could occur all day. Sources probably responsible for most of the higher values are SEDAN crater throw out, infiltrated water from the CAMBRIC ditch, the Rainier Mesa tunnel ponds (dried up now), and the SCHOONER-CABRIOLET-PALANQUIN area. Plants at some locations had low concentrations of tritium, the source of which was unidentified.

EXTERNAL GAMMA EXPOSURES - ONSITE AREA

The TLD network at the NTS in 1996 began with 169 TLDs at fixed locations. Each TLD is fixed on a stake about one meter above the ground to measure ambient beta and gamma radiation. There were 17 TLD locations discontinued, 4 that were relocated, and 8 added at new locations. The year ended with 160 TLD stations. Fifteen of the existing stations had been established as the boundary locations and were reachable by truck as stated in the previous year's report.

Environmental monitoring is done with the UD-814 dosimeters of special design. The UD-814 is a modification of UD-804 environmental dosimeter with the addition of a $Li_2B_4O_7$:Cu element in position one encapsulated in 14 mg/cm^2 to monitor beta particles in the environment. The remaining three elements are replicates of $CaSO_4$:Tm encapsulated in 1,000 mg/cm^2 of plastic and lead. Since $CaSO_4$ is about 30 times more sensitive than $Li_2B_4O_7$:Cu, it makes an excellent phosphor to measure the low doses (10 mR/month) generally encountered in low-level radiation environments. The results for boundary locations are given in Table 5.18. The annual rates ranged from 61 mR/yr to 166 mR/yr.

A group of locations which were not, to the best available knowledge, influenced by radiological contamination, and had been monitored for many years served as controls for the NTS. The data from these locations are presented in Table 5.19. The annual rates ranged from 50 mR/yr to 124 mR/yr, with an overall network average exposure rate of 0.23 mR/day or 84 mR/yr.

An investigation of historical trends in onsite environmental gamma levels, as measured by the TLD network, showed no significant differences among years until 1993, except for data from 1987 (dosimetry system changed) and 1988 (due to a calibration problem). A change in procedure introduced an additional significant change in historical trend data in 1994. A description of this analysis is published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996" (DOE/NV/11718-138, in prep.).

OFFSITE ENVIRONMENTAL SURVEILLANCE

The R&IE-LV offsite environmental surveillance program was operated to detect any releases of radioactivity related to current NTS activities which could potentially result in human exposure. Monitoring was concentrated on possible human exposure pathways. Monitoring locations were generally selected to represent inhabited areas around the NTS. Monitoring was not designed to provide full spatial characterization of the offsite area, nor was the monitoring designed to detect all types of radioactivity arising from all natural and man-made sources. Possible pathways monitored included inhalation, ingestion, and external exposure. In brief (a full description is in Chapter 4), the following was done.

Alpha, beta, and gamma radiation in air were monitored by the Air Surveillance Network

(ASN), which included 20 continuously operating stations around the NTS. Noble gas and atmospheric moisture samplers were discontinued in 1994. Groundwater and some surface water supplies were sampled regularly in the Long-Term Hydrological Monitoring Program (LTHMP). Water sampling locations included 37 wells on the NTS, or immediately outside its borders and 32 locations in the offsite area. Not all locations are sampled every year. The Milk Surveillance Network (MSN) consisted of annual collections from 11 locations in the immediate offsite area, of which 10 were sampled this year. The network included family-owned cows and goats and commercial dairies.

External gamma radiation was monitored by the Pressurized Ion Chamber (PIC) Network and the TLD Network. The PIC network included 27 stations that were connected by satellite telemetry to the NTS for real-time data collection. Approximately 26 local residents voluntarily participated in the TLD network and another 51 TLDs were located at fixed environmental stations.

The results of monitoring conducted in 1996 are discussed in the following subsections for each of the environmental surveillance networks mentioned above. No major accidental releases of radionuclides from the NTS were reported in 1996. All individual sample data are published separately, but summary data are included herein.

AIR MONITORING NETWORKS

The following sections describe results for the ASN. The atmospheric monitoring network measures the major radionuclides which could potentially be emitted from activities on the NTS, as well as naturally occurring radionuclides. This network represents the possible inhalation exposure pathway for the general public.

AIR SURVEILLANCE NETWORK

Gamma spectrometry was performed promptly on all ASN high- and low-volume samples. The majority of the samples were gamma-spectrum negligible (i.e., no gamma-emitting radionuclides detected). Naturally occurring ^{7}Be was detected occasionally by the low-volume network of samplers. It was detected consistently by the high-volume sample method with an average annual activity of 2.4×10^{-13} µCi/mL.

As in previous years, the gross beta results from the low-volume sampling network consistently exceeded the analytical MDC. The annual average gross beta activity was $1.42 \pm 0.58 \times 10^{-14}$ µCi/mL ($5.3 \pm 2.1 \times 10^{-4}$ Bq/m^3). Summary results for the ASN are in Table 5.20. Individual results are published separately and may be found in the "Environmental Data Report for the Nevada Test Site - 1996," (DOE/NV/11718-138, in prep.).

Gross alpha analysis was performed on all low-volume network samples. The average annual gross alpha activity was 1.3×10^{-15} µCi/mL (48 µBq/m^3). Summary results for the ASN are shown in Table 5.21.

Samples collected at high-volume sampling sites were composited by month and analyzed for plutonium isotopes. Due to a lower limit of detection for high-volume sampling and analysis methods, environmental levels of plutonium were occasionally detected at all six of the sampling sites. This report contains results for samples collected during the third and fourth quarter of 1995 and throughout calendar year 1996 (CY96) (Table 5.22). The maximum average concentration of plutonium was in a sample from Amargosa Valley (Lathrop Wells), but was just 1.3 percent of the DCG.

WATER MONITORING

Environmental surveillance of water in the offsite areas is conducted as part of the LTHMP. Results are discussed in Chapter 9 of this report.

MILK SURVEILLANCE NETWORK

The average total potassium concentration derived from naturally occurring ^{40}K activity was 1.5 g/L for samples analyzed by gamma spectrometry. Selected MSN milk samples were analyzed for ^{89}Sr and ^{90}Sr, and the results are similar to those obtained in previous years; neither increasing nor decreasing trends are evident. The MSN network average values are shown in Table 5.23 for ^{89}Sr and ^{90}Sr.

THERMOLUMINESCENT DOSIMETRY NETWORK

OFFSITE STATION NETWORK

There were 51 offsite environmental stations monitored using TLDs. Figure 4.7 shows current fixed environmental monitoring locations. Total annual exposure for 1996 ranged from 59 mR (0.59 mSv) per year at St. George, Utah, to 133 mR (1.3 mSv) per year at Manhattan, Nevada, with a mean annual exposure of 93 mR (0.93 mSv) per year for all operating locations. The next highest annual exposure was 130 mR (1.3 mSv) per year at Queen City Summit, Nevada. These results are consistent with those for 1995.

OFFSITE PERSONNEL NETWORK

Twenty-five offsite residents were issued TLDs to monitor their annual dose equivalent. Locations of personnel monitoring participants are also shown in Figure 4.7. Annual whole body dose equivalents ranged from a low of 48 mrem (0.48 mSv) to a high of 125 mrem (1.2 mSv) with a mean of 96 mrem (0.96 mSv) for all monitored personnel during 1996. These results are similar to those for 1995.

PRESSURIZED ION CHAMBER NETWORK

The PIC data presented in this section are based on monthly averages of gamma exposure rates from each station. Table 5.24 contains the number of monthly averages available from each station and the maximum, minimum, mean, standard deviation, and median of the monthly averages. The mean ranged from 8.0 µR/hr at Pahrump, Nevada, to 17.7 µR/hr at Tonopah, Nevada, or annual exposures from 71 to 156 mR (18 to 40 µC/kg). The table shows the total mR/yr (calculation based on the mean of the monthly averages) and the average gamma exposure rate for each station. Background levels of environmental gamma exposure rates in the United States (from the combined effects of terrestrial and cosmic sources) vary between 49 and 247 mR/yr (13 to 64 µC/kg-yr) (BEIR III 1980). The annual exposure levels observed at each PIC station are well within these United States background levels. Figure 5.10 shows the distribution of the monthly averages from each PIC station. The horizontal lines extend from the mean value (◆) to the minimum and maximum values. The vertical lines are the approximate United States background range.

The data from Milford, Rachel, Twin Springs, and Uhalde's Ranch stations show the greatest range and the most variability. These data are within a few tenths µR/hr from those of last year.

NON-NTS BN FACILITY MONITORING

BN facilities which use radioactive sources or radiation producing equipment with the potential to expose the general population outside the property line to direct radiation are as follows: the Special Technologies Laboratory (STL) during operation of the Sealed Tube Neutron Generator, STL during operation of the Febetron, the Remote Sensing Laboratory (RSL) at Nellis Air Force Base, the North Las Vegas Facility (NLVF) Atlas A-1 Source Range, and the Washington Aerial Measurements Operation (WAMO). Sealed sources are tested every six months to ensure there is no leakage of radioactive material and the data are kept in the BN Radiation Protection Records.

Click to view Figure 5.10

Figure 5.10 Distribution of Averages from Each PIC Network Station - 1996

Operation of radiation-generating devices is controlled by BN procedures.

Fence line radiation monitoring at STL, RSL, NLVF, and WAMO was conducted during 1996 using Panasonic Type UD-814 TLDs. At least two TLDs were at the fence line on each side of any facility. TLDs were exchanged on a quarterly basis with additional control TLDs kept in a shielded safe. These TLD results are given in Table 5.25. TLD results were not available for WAMO. The range of results, 52 to 115 mR/yr, is within the background range in the continental United States.